Department of Agriculture

Forest Service

Forest Pest Management

Davis, CA

USER MANUAL FOR THE SPREAD FACTOR DATABASE

FPM 94-14
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Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.

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User Manual for the Spread Factor Database

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TABLE OF CONTENTS

1. INTRODUCTION

The term spread factor refers to the ratio of stain diameter on a witness card to droplet diameter. It is a means of determining mass deposition from a spray mission. Accurate measurement of spread factor is crucial to any analysis of spray deposition because an error in droplet diameter is magnified by a factor of three when estimating volume. Spread factor varies with drop size and is generally expressed by linear, polynomial or power law functions. Teske, MacNichol and Barry (1993) give a concise review of the development and use of spread factor technology.

Precise descriptions of spread factor relationships are of particular interest when evaluating aerosol spray droplets generated during aerial application of pesticides used in forest and crop protection. Thus, the USDA Forest Service and its cooperators have collected and interpreted spread factor data for the last 40 years. The database presented here is a compendium of spread factor data available up to the present time. In addition to a summary of USDA Forest Service data (Barry 1993), the database includes information from a variety of laboratory and field tests dating from 1960 to the present.

These data point to the wide range of collection and interpretation techniques used, and strongly suggest that a single source (from within the USDA Forest Service) should be available as a compilation and maintenance center for spread factor information. The chief purpose of the database is to provide a thorough summary of spread factor data in a format which is easy to read and easy to sort by specific category. This work is a natural extension of efforts to quantify all of the ingredients needed for a successful interpretation of aerial field trials, and consistency when comparing field results with aerial spray models such as FSCBG (MacNichol and Teske 1993a, 1993b, 1994).

Many factors can affect the spread factor relationship, including physical properties of the spray material, state of the drop before impaction, drying conditions, and the type of collector surface used. It is especially important to describe carefully the spray material in use. Concentration of active ingredients and their dilution in a specific base, dye concentration, and additives to the tank mix all affect the spread factor relationship. The nature of the collecting substrate is also an important consideration.

Each entry in the database (henceforth called an input) is defined by: type of formulation; composition of formulation; collector surface used; relation of stain size to drop size (in the form of a curve fit with regression coefficients); and reference information. Information from the database may be viewed on the screen or output to a printer in several different formats, and may also be sorted by specific categories (e.g., by type of formulation or by type of collector surface).

There are currently over 250 inputs in the database.

The spread factor database has been set up using Paradox® for Windows version 1.0 , available through Borland International (Scotts Valley, CA). This software is PC compatible and can be installed on a network or on a standalone computer.

2. DATABASE STRUCTURE

There are thirteen categories of information for each input: active ingredient, base (oil or water), composition, dye, year, reference, collector surface, equation type (refers to curve fit type), regression coefficient A, regression coefficient B, regression coefficient C, specific gravity and comments. Each of these categories corresponds to a column in the database:

1. **Active**: Name of formulation, or active ingredient. The INGREDIENTS LIST section gives a summary of all ingredients in the database.

2. **Base**: For formulations diluted with **water** or **oil**.

3. **Composition**: given in %; gaseous ingredients given in grams per liter.

   a. Neat: undiluted active ingredient.

   b. If **Base** is water, composition includes all **other** ingredients (except dye).

   c. If **Base** is oil, composition includes **all** ingredients (except dye) and the oil base used.

   d. If there is no mention of additives, the name given for the formulation is listed as active ingredient and the composition is listed as "unknown".

   e. Ingredients which were originally defined in % w/v (percent by weight) are listed this way in the database.

   f. When an ingredient was originally defined in terms of mass per unit of volume (e.g., lb of ingredient per gallon of water), the composition is listed in % and is flagged with a **#**.

   g. Some references describe formulations in greater detail than others; when available, further details are noted and are summarized in the INGREDIENTS LIST section.

4. **Dye**: If a dye is present, it is given. If the concentration is known it is given in %.

   a. When the concentration was originally listed in % w/v, it is so listed in the database. Otherwise, the concentration of powdered dyes is given in grams per liter (g/l).

   b. If the reference clearly states that no dye was used, this entry reads "none"; otherwise, it reads "unknown". However, note that if Kromekote cards (or other white cards) were used, there probably was some type of dye added to the formulation.

c. Detailed information on some water and oil soluble dyes is available in Barry et al. (1978), Table 1 (p.18).

d. The LIST OF DYES section gives a summary of all dyes included in the database.

5. **Year**: The year of publication of the reference for the entry.

6. **Reference**: This is a summary of source information. See the REFERENCES for full information on source material used in the database. Note that there may be further reference information in the **Comments** column (no. 13).

a. UCD refers to the University of California at Davis.

7. **Collector surface**: Data is available for many different collector surfaces. Note that if a card such as Kromekote is used, different batches of the same type of Kromekote can give different results in spread factor investigations. There may thus be two or more entries in the database which are identical, but give different regression equations because different batches of Kromekote cards were used (specific information about Kromekote cards is given whenever available). A complete list of the collector surfaces used is included in the COLLECTOR SURFACES section.

8. **Equation type**: Spread factor regression can be defined by one of three curve fits (Teske 1992):

1. $(\text{Drop Diameter}) = A + B * (\text{Stain Diameter}) + C * (\text{Stain Diameter})^2$

2. $(\text{Stain Diameter}) = A + B * (\text{Drop Diameter}) + C * (\text{Drop Diameter})^2$

3. $(\text{Drop Diameter}) = A * (\text{Stain Diameter})^B$

9., 10., 11. **A**, **B**, **C**: These are the corresponding coefficients for the spread factor regression curve fit.

12. **Specific Gravity**: This is the specific gravity of the formulation entered, given where available.

13. **Comments**: Brief comments regarding the input entered, including test program from which the data originated, more information about the composition or collector surface, and further reference information.

3. DATABASE OPERATION

The database can be accessed using Borland Paradox® for Windows (version 1.0 is the most recent version available at this time) or Paradox® version 4.0 for DOS. Directions which follow are given first for the DOS version, then in italics for the Windows version (if only one set of directions is given then they are the same for both versions). Please note that in the Windows version of Paradox the name of an icon can be found in the bottom left corner of the screen when the mouse is moved over that icon.

1. INSTALLATION

This section assumes that the user is operating a standalone computer equipped with a mouse. To install the spread factor database, the data disk supplied should be copied into Paradox using the following procedure:

- Install Paradox on the desired drive of an IBM compatible PC. Paradox will appear in a directory called *drive***pdox40**.

- Copy all files on the floppy disk labeled **SPFACTOR Data** into this directory. The database now exists as a *table* in Paradox. Several possible report formats are also installed.

- Enter Paradox with the command **paradox**. The Paradox main screen will appear. This is a blank screen with a command bar across the top. Each command within Paradox is performed by moving the cursor to the appropriate menu item and clicking once on the desired command. To return to a previous menu, use the *escape* key.

- *Windows: Enter Paradox by clicking on the appropriate icon. You will be asked for a* password. The password is "spf." *Paradox creates a* desktop *which shows icons and data specific to the directory in which you are working (this will be a default directory with a blank table if you have never entered the program before). Specify your* working directory *(in the* File *menu on the main menu bar) as that directory in which you have placed the spread factor database. As long as this directory remains your designated working directory, you will automatically go into the spread factor database desktop whenever you enter Paradox.*

2. SORTING DATA

Data can be viewed by specific category using the **Ask** command (in DOS) and the **Query** command (in Windows) to query the database. To illustrate how these commands work, the following sections will show how to view all entries from 1978 for the active ingredient Orthene.

Viewing specified portions of the database

Click on the **Ask** command in the top menu bar. A menu box appears asking you for the name of the table you wish to query. Type "spf" and click "OK". A window appears at the top of the screen; its title is **Query Spf**. The window contains each column from the database (the spf table).

The **Ask** command produces a new file on the screen (the **answer file**) which contains all information indicated in this window. Pressing the **F6** function key places a check mark (√) in the column the cursor is in. This marks the information in that column as information to be included in the "answer" file.

Windows: Choose the New, Query *option from the* File *menu on the main menu bar. Indicate the correct table name (spf.db). A* query window *will appear. The top of the window shows each column of the database. An empty box is in each column. Click and hold on this box to see check mark options. The option of interest here is the √ option (the √+ option will work as well). Note that the first column listed gives the name of the database file and should be left alone. As in the DOS version, an* answer file *will be created according to the information marked in the query file.*

If only certain information from the column is desired, this information should be typed following the √. For example, if the **answer file** is to contain all entries in the database that were produced in the year 1978, move the cursor to the "Year" column, press F6, then type "1978".

The **answer file** will **only** contain information from the columns checked off. Thus, if we want to see the active ingredient and composition of all entries from 1978 then three columns should be checked off (Active, Composition and Year) and "1978" should be typed in the Year column.

> DOS version only: Note that **F6** is a toggle key: if it is used on a column which has already been checked, the check will be removed.
>
> Also note that the first column which appears in the query window, labeled "SPF", is not a column which contains information from the database. If a check is placed in this column, **all** columns will automatically be checked off. This is not recommended as it will produce an **answer file** which contains the entire database!

To produce the **answer file** for active ingredient and composition of all entries from 1978, press the **F2** function key. This key tells Paradox to perform the desired operation.

Windows: Click on the Run Query *icon (a lightning bolt) when you are ready to perform the query.*

The **answer file** will appear on screen. Note that the first column gives answer number, **not** record number. The **answer file** appears in the standard Paradox table format, and can be moved through with the arrow keys or the mouse.

Windows: Please note that the answer file *appears in a default format so numerical table entries such as equation coefficients will appear in different notation and may be truncated. To change the format of a column, after the* answer file *has been created, move to the desired column and choose the* Data *option in the* Properties *menu (main menu bar). The format of the column can now be changed.*

A number of entries for Orthene appear in the **answer file** just generated. In order to see these entries alone, and in greater detail, first clear the screen by pressing the **F8** function key. The query window reappears.

Windows: Close the answer window, *or bring the* query window *to the foreground. Note that you can save an* answer file *for future use.*

To see only entries for Orthene, move the cursor to the "Active" column. Type "Orthene..". The two periods immediately following Orthene indicate that **all** entries that have the word Orthene will be included (Orthene, Orthene 75s, etc.).

To see all information available for these Orthene entries, check off the remaining columns in the query window (Base, Reference, Collector Surface, etc.). Now press **F2** again to see the **answer file** for all Orthene entries from 1978 *(or, in Windows, click on the lightning bolt icon again).*

Further queries can be made from the database by pressing **F8** to return to the query window and redefine the information to appear in the **answer file**.

To exit the **Ask** command entirely, press **alt-F8**. The screen will clear of all windows and only the top command line will remain.

Windows: Further queries can be made by switching back to the query window, *as mentioned above. To exit the* Query *command, close all related windows. Note that* answer files *are tables and can be saved, printed and further sorted just like the main database table.*

3. VIEWING AND PRINTING DATA

The database may be viewed and printed in its entirety, by individual input, or by groups of inputs. It is recommended that data always be viewed on screen prior to printing.

Viewing/printing in tabular format

- Viewing the entire database

Click on the **View** command in the top menu bar. A menu box appears asking for the name of the table you wish to view. Type "spf" and click "OK". The table will appear on screen.

Windows: Choose the Open, Table *option in the* File *menu on the main menu bar and then choose* spf.db . *The table appears on screen. Unless you close the table,*

as long as your working directory is set properly the spread factor database will automatically appear in table form each time you enter Paradox.

The spread factor table is both wider and longer than the screen, and can be scrolled with the cursor or the mouse. Please note that the first column is the Paradox record number and the remaining thirteen columns are as specified in DATABASE STRUCTURE.

Each column entry is called a field. When viewing a field which is wider than the column width on the screen (for example, input no. 162, Composition column), double-click on the field. The cursor will appear as a solid gray box on the first character of the field. The cursor can now be moved through the field using the arrow keys. To go back to viewing the entire table, click once on the field.

Windows: To view the entire field, click on the Field View *icon. To go back to viewing the entire table, click on the icon again.*

It is not possible to print or modify any part of the table while in the **View** command.

To clear the screen, click on the pink box in the upper left corner of the table window.

Windows: All or part of the table can be printed at any time using the Print *icon (or the* Print *option in the* File *menu). More on this below. The table appears as a standard window and can be minimized, maximized or closed by clicking on the appropriate corners.*

• Printing the entire database

Click on the **Report** command in the top menu bar, then on the **Output** command. A menu box appears asking for the name of the table you wish to view. Type "spf" and click "OK".

Choose the **R-Spread Factor Table** option for report type and click "OK". Other options are discussed in the following sections.

Now choose **Printer** and click "OK". Note that this is a long file and will take some time to print. To cancel printing, hit any key and a message will appear on screen stating that printing has been interrupted and offering the option to cancel printing or to resume.

The table will print out by column as follows: columns 1 and 2; column 3; columns 4 and 5; columns 6 and 7; columns 8-11; and columns 12 and 13. The first column on each printed page contains the **record #** of the input. Each set of columns will print for the entire table before the next set begins. Thus, to see all columns of data for a given input it is necessary to look at the appropriate record number rows on five pages of output.

Windows: Click on the Print *icon (or the* Print *option in the* File *menu) and indicate whether you wish to print the entire file or a part of the file. The* Overflow Handling *options allow various formats on output: if you choose* clip to page width, *the table will come out as described above. This option is*

recommended since it is the easiest format to read. Be sure to check that the Printer Setup *dialog box is set properly (*Printer Setup *is an option in the* File *menu).*

It is possible to view the table on screen exactly as it will print by choosing the **Screen** option instead of the Printer option. The table will appear in the same format as it prints. However, the pages are aligned so that an entire row of data input for a given **record #** can be viewed by scrolling horizontally across the screen. Note that column widths and page lengths appear exactly as they have been set to print. Viewing the table on screen is much less cumbersome using the **View** command (as previously described).

Windows: The screen *option is not available in the Windows version.*

• Printing consecutive portions of the database

It is possible to print a few pages of the database at a time. After clicking on the **Report** command from the top menu bar, click on the **Range Output** command, type table name "spf" and click "OK".

Choose the **Spread Factor Table** option for report type and click "OK". Now choose **Printer** and click "OK".

A box will appear asking for **Beginning page number** and then **Ending page number**. Keep in mind that pages are numbered as they appear on the printout of the entire database described above.

To see the pages desired on screen first, choose the **Screen** option instead of the Printer option. The pages appear in a window and can be scrolled through horizontally and vertically. Note that the screen is not as wide as the page. To clear the screen, click on the pink box at the upper left corner of the window.

Windows: To print consecutive portions of the database, click on the Print *icon as described above.*

Viewing/printing individual inputs

Individual inputs or sets of inputs can be viewed or printed in another format called **report format**. This format presents all of the information about a given input on one page. A sample page of the spread factor database printed in report format using the Windows version of Paradox is shown in Figure 1. Since a printed page of the database in this format shows three or four consecutive inputs at a time, it is advisable to view the table on screen before any printing is done to verify the page numbers desired. Note that inputs are not entered alphabetically, and that Paradox identifies inputs by record number.

• Viewing the entire table in report format

Click on the **Report** command in the top menu bar, then on the **Output** command. A menu box appears asking for the name of the table you wish to view. Type "spf" and click "OK".

A box appears with options for different types of reports. Click on the desired type of report (see below) and then choose **Screen** in the next menu box.

Note that it is not possible to print or modify any part of the table while in the **Report** command. To clear the screen, click on the pink box at the upper left corner of the window.

Windows: Choose the Open, Report *option in the* File *menu and indicate the desired type of report to be viewed (see below).*

The following options are available:

•• option **1-REPORT 1**: All information pertaining to a given input appears on screen at one time in an easily readable format (see Figure 1). Inputs are listed consecutively by **record #**. When scrolling vertically through the file generated with this option, double lines denote page-break markers. Note that each printed page (8.5 by 11 inches) generated with Report 1 will show three consecutive inputs.

•• option **2 -REPORT 2**: This is the same format as Report 1, but only one input appears per page.

*Windows: The same two report options are available. Option **1** is generated by choosing the* SPFR1.RSL *file and option **2** is generated by choosing* SPFR2.RSL. *In this version of Paradox, option **1** gives four inputs to a page, appearing in four boxes. Option **2** gives one input on a page with no border around it. In either case, inputs will appear consecutively by record number (although the record number does **not** appear in print).*

• Printing the entire table in report format

To print the table in either of the formats described above, choose **Report** and **Output**, then the **Print** option instead of the **Screen** option. Remember that the database is long and will take some time to print entirely. As previously discussed, depressing any key will temporarily stop printing.

Windows: To print the entire table or any portion of it in either of the report formats, choose the Open, Report *option in the* File *menu. Either click on the* printer icon *below the main menu bar or choose the* Print *option in the* File *menu. Again, the "*Clip to Page Width*" option in the Overflow Handling dialog box is recommended.*

• Printing consecutive portions of the database in report format

It is possible to print a few pages of the database at a time in either report format. After clicking on the **Report** command from the top menu bar, click on the **Range Output** command, type table name "spf" and click "OK".

Choose the report option desired and click "OK". Now choose **Printer** and click "OK".

A box will appear asking for **Beginning page number** and then **Ending page number**. Keep in mind that pages are numbered as they appear on the printout of the entire database in whichever report format is desired. When exercising the Report 2 option, keep in mind that three *consecutive* record numbers print out per page; thus, page 1 will show record # 1, 2 and 3 and page 10 will show record # 28, 29, and 30.

To view a portion of the database on screen in report format, invoke the **Range Output** command as described above and choose **Screen** instead of **Printer**.

Windows: To print consecutive portions of the database in report format, choose the Open, Report *option in the* File *menu and click on the* Print *icon as described above.*

Active :	Teknar
Base :	
Composition :	Neat
Dye :	Unknown
Year :	1980
Reference :	UCD Haq
Collector Surface :	Kromekote
Eqn Type :	1
A :	-38.747343
B :	0.643319
C :	-0.00005
Spec Grav :	1.05
Comments :	

Active :	Thuricide 32LV
Base :	Water
Composition :	Thuricide 32LV 50%
Dye :	Unknown
Year :	1980
Reference :	UCD Haq
Collector Surface :	Kromekote
Eqn Type :	1
A :	34.945496
B :	0.264188
C :	0.000239
Spec Grav :	1.1
Comments :	

Active :	Thuricide 32LV
Base :	
Composition :	Neat
Dye :	Unspecified tracer dye
Year :	1983
Reference :	O'Neal
Collector Surface :	Kromekote
Eqn Type :	1
A :	72.08
B :	0.608
C :	-0.000057
Spec Grav :	
Comments :	Maine budworm

Active :	Thuricide 32LV
Base :	
Composition :	Unknown
Dye :	Unspecified tracer dye
Year :	1983
Reference :	O'Neal
Collector Surface :	Kromekote
Eqn Type :	1
A :	11.51
B :	0.5537
C :	-0.00005198
Spec Grav :	
Comments :	Maine budworm

Figure 1: Report Format #1, produced with the Windows version of Paradox. The page shown, number 25, lists record nos. 97 through 100.

4. INGREDIENTS LIST

This section contains an alphabetical summary of all ingredients included in the spread factor database. Detailed information is included wherever available.

- 2, 4-D
- 2, 4, 5-T
- ABG-6223: Abbott Laboratories.
- AID-585: Matacil 180F + ID 585 (Sundaram, Sundaram and Leung 1991).
- Ambush: Formulation concentrate, no particulates. This is a commercial formulation of permethrin. Chipman, Inc.; Ontario, Canada (Sundaram et al. 1993).
- Amin-28: Atlox 3409F + Fenitrothion (technical) (Sundaram et al. 1993).
- Atlox 3409F: Surfactant, no particulates. This is a water-soluble blend of non-ionic and anionic surfactants. Atkemix, Inc.; Ontario, Canada (Sundaram et al. 1993).
- Bactospiene
- BEM: Bioethanometrin (Barry et al. 1978).
- Benlate
- Biofilm
- Canola oil: Canada Packers (Sundaram, Sundaram and Leung 1991).
- Chevron C oil
- Chevron C-10 oil
- Cstk: Chevron sticker
- CIB: Cargill insecticide base-molasses (Barry et al. 1978).
- Copolymer: A thickener composed of 80% PMMA and 7% ethyl and 13% butyl acrylate. Rohm & Haas, no. 7407XP; Philadelphia, PA (Cooper and Jolliffe 1978).
- Corn oil: Canada Packers (Sundaram, Sundaram and Leung 1991).
- Cyclosol 63: Shell; Ontario, Canada (Sundaram, Sundaram and Leung 1991).

- DDT: Beltsville DDT (Maksymiuk and Moore 1962).

- DEM: Diethyl malonate (Matta and Tytus 1987).

- Detergent: Any material normally used as a cleansing agent. May be used as a wetting agent due to its ability to reduce the surface tension of water droplets (Maksymiuk 1977).

- DFB-7: Zectran UCZF-19 + Triton X-114 (Sundaram et al. 1993).

- Diesel fuel

- Dimilin

- Dimilin SC-48: Formulation concentrate, with particulates. This is a commercial formulation of diflubenzuron (DFB). Duphar, B.V.; Weesp, The Netherlands (Sundaram et al. 1993).

- Dimilin WP

- Dipel 6AF: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety. Abbott Laboratories.

- Dipel 6L: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety. Abbott Laboratories. This is an oil-based, emulsifiable suspension formulated with enough emulsifier to permit mixing with water at ratios greater than 50:50 water to Dipel (Skyler 1994).

- Dipel 8AF: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety. Abbott Laboratories.

- Dipel 8L: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety. Abbott Laboratories.

- Dipel 12L: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety. Abbott Laboratories.

- Dipel Biofilm

- Dipel F-1

- Dipel F-16

- Dipel F-3

- Dipel LC

- Dipel Sorbo

- Dipel WB

- Dipel WP

- Dowanol TPM

- Dylox
- Dylox 1.5 oil
- Dylox 4
- Ecogen Condor
- Elvacite: DuPont, no. 2041; Wilmington, DE (Cooper and Jolliffe 1978).
- Entotech Carrier: Entotech Carrier 244, a nuclear polyhedrous virus (NPV).
- Ethylene glycol
- Exsol-D: Esso Chemical; Ontario, Canada (Sundaram, Sundaram and Leung 1991).
- Fe-Cano: Fenitrothion (technical) + Canola oil (Sundaram, Sundaram and Leung 1991).
- Fe-Cycl: Fenitrothion (technical) + Cyclosol (Sundaram, Sundaram and Leung 1991).
- FeCl3
- Fen-Atlo-5: Fenitrothion (technical) + Atlox 3409F (Sundaram et al. 1993).
- Fenitrothion (technical): Pesticide, no particulates. Technical Fenitrothion has > 97% purity. Sumitomo Chemical; Osaka, Japan (Sundaram, Sundaram and Leung 1991, and Sundaram et al. 1993).
- Foray 48B: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety. Novo Laboratories Inc.; Danbury, CT.
- Fuel oil: Many types of fuel oil are mentioned in the database inputs. The spreading properties of fuel oil differ, and terminology differs according to the type of oil purchased. Consequently, the exact name given is listed for each input. Some of these names are:
  - "eastern fuel oil": probably a paraffin-base oil (Maksymiuk and Moore 1962).
  - eastern no.2
  - "western fuel oil": probably an asphalt-base oil (Maksymiuk and Moore 1962).
- Futura XLV: Chemagro Ltd.; Ontario, Canada (Sundaram 1993).
- Futura XLV-HP: Chemagro, Ltd.; Ontario, Canada (Sundaram 1993).
- Glycerine
- Guthion
- Gypchek: A nuclear polyhedrous virus (NPV).

- Hi Sol 4-5-T
- Hi Sol oil
- Hi-Solv 473: Methyl naphthalene solvent (Maksymiuk and Moore 1962).
- Hm oil: Heavy mineral oil.
- ID 585: Shell; Ontario, Canada (Sundaram, Sundaram and Leung 1991).
- Imidan IE
- Isopar-M: Esso Chemical; Ontario, Canada (Sundaram, Sundaram and Leung 1991).
- K-125: Copolymer consisting of 80% polymethyl methacrylate and 20% poly (ethyl/butyl acrylate). Rohm & Haas Co., lot # 3-6326 (Matta and Tytus 1987 and Sommerville and Matta 1990a).
- Kerosene oil
- Klearol oil
- Kolker monosolvent
- Lo-drift
- Malathion
- Malathion-Med-Fly bait: Malathion added to a sweet media that attracts Mediterranean fruit flies (Skyler 1994).
- Matacil (aminocarb): Probably less concentrated than Matacil 180, described below (Skyler 1994).
- Matacil 180D: Formulation concentrate, with particulates. This is a commercial formulation of aminocarb. Chemagro Ltd.; Ontario, Canada (Sundaram et al. 1993).
- Matacil 180F: Chemagro Ltd.; Ontario, Canada (Sundaram, Sundaram and Leung 1991, and Sundaram et al. 1993).
- May: Maywood formula.
- Mexa-28: Zectran UCZF-19 + Triton X-114 (Sundaram et al. 1993).
- MNSO4
- Molasses
- Nalco-trol
- Nitrogen

- No-foam
- NP Virus #3: A nuclear polyhedrous virus.
- NP Virus #4: A nuclear polyhedrous virus.
- Orchex 796
- Orthene 75S: Forestry formulation of Orthene, which is a form of acephate (Skyler 1994).
- Orthene 75SP
- Orthene Forest Spray
- Panasol oil
- Perm-7: Ambush + water (Sundaram et al. 1993).
- PMMA: A thickener composed of polymethylmethacrylate. Rohm & Haas, no. S5522; Philadelphia, PA (Cooper and Jolliffe 1978).
- Pydrin
- Pyrethrins
- R-11
- Roundup: Contains glyphosate. Monsanto.
- Saline solution
- San418 32LV: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk) (Mierzejewski 1991).
- Sandoz
- Sevin #1 (carbaryl)
- Sevin #2 (carbaryl)
- Sevin #3 (carbaryl)
- Sevin #4: Union Carbide.
- Sevin #4 (carbaryl)
- Sevin FR
- Shade
- Sorbo

- Sovacide: Mobisol 544-B (Maksymiuk and Moore 1962).

- Soybean oil: Canada Packers (Sundaram, Sundaram and Leung 1991).

- Stb: Stabilizers, unspecified (Barry et al. 1978).

- Sticker: This is probably Chevron sticker (Barry et al. 1978). In general, a material added to a pesticide to increase its adherence (Maksymiuk 1977).

- Sumithion

- Sumithion F20: Also "Sumithion 20% flowable". Sumitomo Chemical; Osaka, Japan (Cadogan 1986).

- Sumithion tech: Also Sumithion technical E.C. Sumitomo Chemical; Osaka, Japan (Cadogan 1986).

- Sun 6N oil

- Suncropspray 11N: Sunoco; Ontario, Canada (Sundaram, Sundaram and Leung 1991).

- Sunflower oil: Canada Packers (Sundaram, Sundaram and Leung 1991).

- Sunspray 7N: Sunoco; Ontario, Canada (Sundaram, Sundaram and Leung 1991).

- Superior oil #70: Chipman Chemical; Ontario, Canada (Sundaram, Sundaram and Leung 1991).

- Teknar

- Thuricide 16B: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety.

- Thuricide 24B: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety.

- Thuricide 32LV: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety. Comprised of 1.6% Btk, 98.4% inert ingredients. Sandoz Inc.; San Diego, CA.

- Thuricide 34B Sorbo

- Thuricide 48B: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety.

- Thuricide 48B-1

- Thuricide 48B-2

- Thuricide 48LV: Active ingredient is *Bacillus thuringiensis kurstaki* (Btk), Berliner variety.

Note 1: Thuricide 48LV, this reference cites Zoecon Corp.; Palo Alto, CA.

- Thuricide HPC #3

- Thuricide 64LV

- Triclopyr

- Triton X-114: Surfactant, no particulates. A non-ionic, water-soluble surfactant. Rohm and Haas; Ontario, Canada (Sundaram et al. 1993).

- Water: •• distilled water when so noted.
  •• raindrops.

- Wingstay 100: B.F. Goodrich (Barry et al. 1978).

- Zectran: A form of mexacarbate (carbamate group of pesticides), first developed and marketed by the Dow Chemical Company.

- Zectran FS-15: Zectran in solution with tri-propylene-monomethyl glycol ether (TPM). 1.5 lb Zectran in 1 gallon of TPM (Taylor et al. 1978).

- Zectran FS1.5

- Zectran UCZF-19: Formulation concentrate, with particulates. This is a commercial formulation of mexacarbate. Union Carbide Co., Ltd.; Ontario, Canada (Sundaram et al. 1993).

5. LIST OF DYES

This section contains an alphabetical summary of all dyes included in the database. Detailed information is included wherever available. Dyes and tracers are often added to tank mixes for the purpose of measuring the spray deposits. Types of dyes listed include fluorescent and non-fluorescent dyes, fluorescent particles, chemical tracers, and ultraviolet screeners. Dyes included in Barry et al. (1978), Table 1 (p.18) are marked ***.

- Av blue: Aviation blue
- Automate dye
- Automate red
- Automate red B ***
- Blue #2
- BSF: Brilliant Sulpho Flavine ***
- Bullseye Blue
- Calco Oil Blue ZV
- Cf: Calcofluor ***
- Ceres blue: Ceres Blue ZV, also known commercially as Calco Oil Blue ZV. Complete description in Sommerville and Matta (1990a), Appendix A.
- Day-glo
- Day-glo (fire orange)
- Dieldrin: Dieldrin @ .01004 g + soluble fluorescent dye @ 2.0636 g + 10^7 FPs (fluorescent particles) per ml (Himel et al. 1965).
- DHBP: Dihydroxybenzonephenone, sold under the trade name of Syntase 100. Neville Syntheses Organics; Pittsburgh, PA.
- Erio acid red: Erio acid red XB400. Ciba Geigy; Quebec, Canada.
- Geigy red herbicide
- Nigrosine ***
- Oil red (CI 258)
- Oil red #0 ***

- Oil red B
- Oleopaprica
- Red #40
- Rhodamine
- Rhodamine B ***: A water soluble powder used up to about 1980 (Skyler 1994).
- Rhodamine B extra S ***: Used for oil tank mixes (e.g.., Zectran and DDT). Not used after the late 1970's (Skyler 1994).
- Rhodamine B extra Base ***
- Rhodamine BX: Used in 1980 at Withlacoochee and for a few years afterwards (Skyler 1994).
- Rhodamine WT: A red, water-soluble liquid fluorescent dye. This type of Rhodamine has been in use since about 1980 and is the type presently used (Skyler 1994). Keystone Aniline Corp; La Miranda, CA.
- RWP: Calcofluor White RW, a fluorescent tracer. Also known as RWP Concentrate and Tinopal SWN Dye. Complete description in Sommerville and Matta (1990a), Appendix A.
- Sudan black ***
- Sudan deep black
- TEP: triethyl phosphate, a chemical tracer.
- Uv: Uvinul 400, an ultraviolet screener

6. COLLECTOR SURFACES

This section contains an alphabetical summary of all collector surfaces included in the spread factor database. Detailed information is included wherever available.

Paper witness cards are most commonly used to assess spray deposition in forestry spraying. Some of the first surfaces were simple white cards, followed by Printflex cards (no longer available), followed by Kromekote cards. White Kromekote cards are the most widely used cards today (Teske, MacNichol and Barry 1993).

Other collector surfaces included in the database are: collector plates; filter disks; silver-nitrate agar; and real and simulated foliage. Many of these are discussed by Teske, MacNichol and Barry (1993).

Some of the descriptive information below (for Kromekote 2CS, Kodak 480, Ciba Geigy yellow, 3M paper, Oil sensitive red cards and Sudan black cards) is taken from Kautz and Ekblad (1984).

- 3M paper: 3M copy paper, a white thermofax copy paper.
- Bond paper: High grade bond paper (Cadogan 1967).
- Ciba Geigy yellow: Water-sensitive white paper coated with a yellow dye that turns dark blue when sprayed with water or a water-base tank mix.
- ESC sensitive paper: Unspecified paper provided by Environmental Systems Corporation (ESC) (Webb, Culver and Laulainen 1979).
- Foliage: •• Douglas fir
- Kodak 480: Kodak linagraph 480 paper, a photosensitive paper made for seismographs.
- Kromekote: Paper cards commonly used for spray deposit sampling. Unless otherwise noted, Kromekote cards are glossy white (undyed). Some Kromekote cards are glossy on both sides, some only on one side. The glossy side is always the collector surface. Several different types of Kromekote are listed in the database, including:
  - •• Kromekote cov. white 2CS: white with glossy surfaces on both sides.
  - •• Kromekote (1): white with one glossy side.
  - •• Kromekote (2): white with both sides glossy.
- Meyer paper: Paper employed in the field test referenced in Webb, Culver and Laulainen (1979), manufactured by J.H. Meyer of Silver Spring, MD.
- Millipore filter disks: Type HA (Cadogan 1967).
- Mylar sheets

- Needles:
  - aluminum, wax-coated
  - Douglas fir
  - Douglas fir, top
  - Douglas fir, bottom
  - natural Balsam fir

- Oil sensitive red cards: Kromekote cards coated with a red dye.

- Petri dishes

- Photo method

- Printflex: A white, glossy, finished commercial-printing paper. Further defined as Mead Offset Enamel Cover sub 80 (Cooper and Jolliffe, 1978) and as Printflex Cover 80 lb., Meade Paper Corp., Chillicothe, OH (Maksymiuk and Moore, 1962).

- Silver nitrate-agar: 5% chloride-free agar gel with 6% silver nitrate (Cadogan 1967).

- Sudan black cards: Kromekote cards that have been dyed black in order to be oil-sensitive.

- Whatman #1 filter paper

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